

This Page Is Inserted by IFW Operations
and is not a part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

**As rescanning documents *will not* correct images,
please do not report the images to the
Image Problem Mailbox.**

REMARKS

Entry of the foregoing, re-examination and reconsideration of the subject matter identified in caption, as amended, pursuant to and consistent with 37 C.F.R. §1.116, and in light of the remarks which follow, are respectfully requested.

By the present amendment, the feature of claim 11 has been added to claim 1 as suggested by Examiner Hon in paragraph (1) of the Final Rejection. Thus, the low-refractive index layer generally follows the contours of the surface of the hard coat layer and maintains the concavo-convex structure formed by the particles in the hard coat layer as shown in Figure 1. Claims 1-10, 12 and 13 are now pending in this application.

PRIORITY CLAIM

Applicants respectfully request that the Patent Office acknowledge receipt of the request for priority under 35 U.S.C. §119 and the filing of a certified copy of Japanese Patent Applications No. 11-29322, 11-29381 and 11-67444 in International Application No. PCT/JP00/00622.

THE REJECTIONS

Claims 1-3, 5 and 7-12 were rejected under 35 U.S.C. §103(a) as unpatentable over U.S. Patent No. 5,747,152 to *Oka et al.* in view of U.S. Patent No. 3,614,199 to *Altman* for the reasons set forth in paragraph (3) of the Office Action. Reconsideration and withdrawal of this rejection are respectfully requested for at least the reasons which follow.

In the films disclosed in *Oka et al.* '152, the hard coat layer contains ultrafine particles having an average particle diameter of not more than 200 nm, preferably 5 to 70 nm (column 12, lines 17-20). This particle size range is critical in order to attain the objectives of patentees' invention. Thus, *Oka et al.* '152 uses ultrafine particles to form a layer having a particular refractive index (2 in Figure 9 as described in Example 5A). This layer is for the purpose of reducing reflectivity by optical interference, and thus, the layer is required to satisfy the Equations (1) and (2) shown in column 3 of *Oka et al.* '152. A person of ordinary skill in the art would understand that it is important in the invention of *Oka et al.* '152 to satisfy the equations. This can be understood from the discussion in "Optics" (pages 375 and 376, copy enclosed). Page 376 of this reference describes a "double-layer, quarter wavelength antireflection coating" known as an excellent antireflection film.

This conclusion is also supported by the working examples of *Oka et al.* '152. In Example A5 a ZnO layer (ultrafine particle layer) has a thickness of 72 nm. When the design wavelength = 550 nm (column 3, line 29), and the refractive index of ZnO is 1.9 (Examiner A5), the left side of Equation (2) is $72 \times 1.9 = 136.8$, while the right side of Equation (2) is $550/4 = 137.5$. These values are almost the same. Therefore, it is apparent that the ultrafine particle layer of *Oka et al.* '152 is designed according to these conventionally known equations. From the equations, it is understood that, when visible light is considered, the ultrafine particle layer should have a thickness of about 30 nm to 150 nm. This is the reason why it is necessary to use ultrafine particles of a size of not more than 200 nm in *Oka et al.* '152.

In *Altman* '199, an antireflection treatment is conducted after the particles are adhered on the tacky adhesive layer. As opposed to the present invention where the

particles are dispersed in the hard coat layer, *Altman* simply arranges the particles on top of the tacky adhesive layer. Pigment powder 30 is then deposited in the interstices between the particles 28 and an optional antireflection layer 32 is applied. It is clear from a review of *Altman* '199, that the reference does not contemplate an antireflection film but instead, a type of screen having an antireflection function to prevent the reflection of undesired light other than the objective projected image, such as a light on a ceiling, from coming into a viewer's sight. The screen reflects the light coming from the front, to show it as an image. For this purpose, there is a metal layer under the particle layer to reflect the light.

The Office Action theorizes on page 4, lines 5-6, that the particles described in *Altman* '199 have only one size as shown in the Figure and that this implies monodispersity and a particle size distribution of 0.1 or less. Respectfully, Applicants disagree for at least the following reasons.

The particles employed in *Altman* '199 are composed of larger glass microspheres and smaller pigment microspheres. Note column 2, line 73 to column 3, line 13. Thus, this document fails to teach uniformity of particle size. It is believed that no particular particle size uniformity would be required in light of the purpose in *Altman* '199. Therefore, it is submitted that use of the particles disclosed in *Altman* '199 would not result in a low refractive index layer having a uniform concave-convex structure.

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a

reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The motivation to modify the prior art reference must flow from some teaching in the art that suggests the desirability or incentive to make the modifications needed to arrive at the claimed invention. In re Napier, 55 F.2d 610,613; 34 U.S.P.Q.2d 1782,1784 (Fed. Cir. 1995). Obviousness cannot be established by modifying the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the claimed modification. In re Geiger, 815 F.2d 686,688; 2 U.S.P.Q.2d 1276,1278 (Fed. Cir. 1987).

Since the objectives and products of *Oka et al.* '152 are entirely different from those of *Altman* '199, those of ordinary skill would not look in the direction of *Altman* '199 to modify the teachings of *Oka et al.* '152. The particle size of the ultrafine particles in the structures of *Oka et al.* '152 is critical in nature as discussed above. There would be no reasonable expectation by those of ordinary skill that substituting the significantly larger variable-sized particles of *Altman* '199 for the ultrafine particles of *Oka et al.* '152 would be successful.

With respect to present claim 2, the Office Action asserts that a fluorine-series compound has low surface energy and therefore has a coefficient of kinetic friction of 0.20 or less. To the contrary, a low surface energy does not necessarily mean a low coefficient of kinetic friction, as tribology includes many kinds of lubrication. Thus, Viscoat 8F (a crosslinked polymer of a fluorine-series monomer) in Example 5A of *Oka et al.* '152 has a coefficient of kinetic friction larger than 0.20.

For at least the above reasons, the §103(a) rejection of claims 1-3, 5 and 7-12 based on *Oka et al.* '152 in view of *Altman* '199 should be reconsidered and withdrawn. Such action is earnestly requested.

Claims 4, 6 and 13 were rejected under 35 U.S.C. §103(a) as unpatentable over *Oka et al.* '152 in view of *Altman* '199 and further in view of U.S. Patent No. 2,354,049 to *Palmquist* for the reasons provided in paragraph (4) of the Final Rejection. Reconsideration of this rejection is respectfully requested for at least the following reasons.

Present claim 13 specifies a density of particles in the range of 100 to 5000 particles/m². *Altman* '199 discloses that at least 90% of the surface is covered by particles (column 2, lines 70-75). In contrast, the surface coverage of the particles in the film of claim 13 ranges from $1.4 \times 10^{-7} \%$ to $7.7 \times 10^{-6} \%$ when the particle diameter is 3 to 7 μm and the particle density is 200 to 2000 particles/m². Thus, the surface coverage encompassed by claim 13 is significantly smaller than that disclosed in *Altman* '199.

Palmquist '049 discloses that the sheet has 10,000 particles per square inch when particles having an average diameter in the range of 3 to 6 mils are used (lines 6 to 10 in the left column on page 3). This value is equal to 1.5×10^7 particles/m². Therefore, the density of the particles in present claim 13 is remarkably smaller than the particle density described in *Palmquist* '049.

Moreover, in contrast to the cited references, the particles in the film of claim 13 do not play a major role in terms of optical performance of the film. The particles do have an affect on optical performance; for example, too small a particle will cause undesirable haze. However, the major role of the particles in the films of the

invention is to prevent the film from contacting a light-tuning film as discussed on page 8 of the Response filed November 28, 2003.

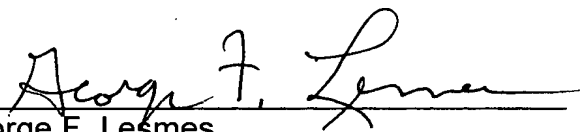
Based on the above distinctions, Applicants respectfully submit that the §103(a) rejection of claims 4, 6 and 13 as obvious over *Oka et al.* '152 in view of *Altman* '199 and further in view of *Palmquist* '049 should be reconsidered and withdrawn. Such action is earnestly solicited.

From the foregoing, further and favorable action in the form of a Notice of Allowance is believed to be next in order and such action is earnestly solicited. If there are any questions concerning this paper or the application in general, the Examiner is invited to telephone the undersigned.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

Date: July 16, 2004

By: 
George F. Lesmes
Registration No. 19,995

P.O. Box 1404
Alexandria, Virginia 22313-1404
(703) 836-6620

Sponsoring editor: Bruce Spatz
Production supervisors: Margaret Pinette and Lorraine Ferrier
Text designer: Joyce Weston
Illustrators: Oxford Illustrators
Art consultant: Lorena Bailey
Manufacturing supervisor: Ann DeLacey

Library of Congress Cataloging-in-Publication Data

Hecht, Eugene.

Optics.

Bibliography: p.

Includes indexes.

I. Optics. I. Zajac, Alfred. II. Title.

QC355.2.H42 1987 535 86-14067

ISBN 0-201-11609-X

Reprinted with corrections May, 1990.

Copyright © 1987, 1974 by Addison-Wesley Publishing Company, Inc.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publisher. Printed in the United States of America. Published simultaneously in Canada.

11 12 13 14 15 MA 96959493

9.7 Applications of Single and Multilayer Films 375

In general, if p is the number of layers, each with a particular value of n and h , then the first and the last boundaries are related by

$$\begin{bmatrix} E_1 \\ H_1 \end{bmatrix} = M_1 M_2 \cdots M_p \begin{bmatrix} E_{(p+1)} \\ H_{(p+1)} \end{bmatrix}. \quad (9.95)$$

The characteristic matrix of the entire system is the resultant of the product (in the proper sequence) of the individual 2×2 matrices, that is,

$$M = M_1 M_2 \cdots M_p = \begin{bmatrix} m_{11} & m_{12} \\ m_{21} & m_{22} \end{bmatrix}. \quad (9.96)$$

To see how all this fits together, we will derive expressions for the amplitude coefficients of reflection and transmission using the above scheme. By reformulating Eq. (9.92) in terms of the boundary conditions [(9.81), (9.82), and (9.84)] and setting

$$Y_0 = \sqrt{\frac{\epsilon_0}{\mu_0}} n_0 \cos \theta_{0i}$$

and

$$Y_i = \sqrt{\frac{\epsilon_0}{\mu_0}} n_i \cos \theta_{ii},$$

we obtain

$$\begin{bmatrix} (E_{1i} + E_{r1}) \\ (E_{1i} - E_{r1})Y_0 \end{bmatrix} = M_1 \begin{bmatrix} E_{1i} \\ E_{1i}Y_i \end{bmatrix}.$$

When the matrices are expanded, the last relation becomes

$$1 + r = m_{11}t + m_{12}Y_i t$$

and

$$(1 - r)Y_0 = m_{21}t + m_{22}Y_i t,$$

as much as

$$r = E_r/E_{1i} \quad \text{and} \quad t = E_{1i}/E_{1i}.$$

Consequently,

$$r = \frac{Y_0 m_{11} + Y_0 Y_i m_{12} - m_{21} - Y_i m_{22}}{Y_0 m_{11} + Y_0 Y_i m_{12} + m_{21} + Y_i m_{22}} \quad (9.97)$$

and

$$t = \frac{2Y_0}{Y_0 m_{11} + Y_0 Y_i m_{12} + m_{21} + Y_i m_{22}}. \quad (9.98)$$

To find either r or t for any configuration of films, we need only compute the characteristic matrices for each film, multiply them, and then substitute the resulting matrix elements into the above equations.

9.7.2 Antireflection Coatings

Now consider the extremely important case of normal incidence, that is,

$$\theta_{0i} = \theta_{1i} = \theta_{1t} = 0,$$

which in addition to being the simplest, is also quite frequently approximated in practical situations. If we put a subscript on r to indicate the number of layers present, the reflection coefficient for a single film becomes

$$r_1 = \frac{n_1(n_0 - n_s) \cos k_0 h + i(n_0 n_s - n_1^2) \sin k_0 h}{n_1(n_0 + n_s) \cos k_0 h + i(n_0 n_s + n_1^2) \sin k_0 h}. \quad (9.99)$$

Multiplying r_1 by its complex conjugate leads to the reflectance

$$R_1 = \frac{n_1^2(n_0 - n_s)^2 \cos^2 k_0 h + (n_0 n_s - n_1^2)^2 \sin^2 k_0 h}{n_1^2(n_0 + n_s)^2 \cos^2 k_0 h + (n_0 n_s + n_1^2)^2 \sin^2 k_0 h}. \quad (9.100)$$

This formula becomes particularly simple when $k_0 h = \frac{1}{2}\pi$, which is equivalent to saying that the optical thickness h of the film is an odd multiple of $\frac{1}{4}\lambda_0$. In this case $d = \frac{1}{4}\lambda_f$, and

$$R_1 = \frac{(n_0 n_s - n_1^2)^2}{(n_0 n_s + n_1^2)^2} \quad (9.101)$$

which, quite remarkably, will equal zero when

$$n_1^2 = n_0 n_s. \quad (9.102)$$

Generally, d is chosen so that h equals $\frac{1}{4}\lambda_0$ in the yellow-green portion of the visible spectrum, where the eye is most sensitive. Cryolite ($n \approx 1.35$), a sodium aluminum fluoride compound, and magnesium fluoride ($n = 1.38$) are common low-index films. Since MgF_2 is by far the more durable, it is used more frequently. On a glass substrate, ($n_s \approx 1.5$), both these films have indices that are still somewhat too large to satisfy Eq. (9.102). Nonetheless, a single $\frac{1}{4}\lambda_0$ layer of MgF_2 will reduce the reflectance of glass from about 4% to a bit more than 1%, over

376 Chapter 9 Interference

the visible spectrum. It is now common practice to apply antireflection coatings to the elements of optical instruments. On camera lenses, such coatings produce a decrease in the haziness caused by stray internally scattered light, as well as a marked increase in image brightness. At wavelengths on either side of the central yellow-green region, R increases and the lens surface will appear blue-red in reflected light.

For a double-layer, quarter-wavelength antireflection coating.

$$\mathcal{M} = \mathcal{M}_1 \mathcal{M}_{11}$$

or more specifically

$$\mathcal{M} = \begin{bmatrix} 0 & i/Y_1 \\ iY_1 & 0 \end{bmatrix} \begin{bmatrix} 0 & i/Y_2 \\ iY_2 & 0 \end{bmatrix}. \quad (9.103)$$

At normal incidence this becomes

$$\mathcal{M} = \begin{bmatrix} -n_2/n_1 & 0 \\ 0 & -n_1/n_2 \end{bmatrix}. \quad (9.104)$$

Substituting the appropriate matrix elements into Eq. (9.97), yields r_2 , which, when squared, leads to the reflectance

$$R_2 = \left[\frac{n_2^2 n_0 - n_1 n_1^2}{n_2^2 n_0 + n_1 n_1^2} \right]^2. \quad (9.105)$$

For R_2 to be exactly zero at a particular wavelength, we need

$$\left(\frac{n_2}{n_1} \right)^2 = \frac{n_1}{n_0}. \quad (9.106)$$

This kind of film is referred to as a *double-quarter, single-minimum* coating. When n_1 and n_2 are as small as possible, the reflectance will have its single broadest minimum equal to zero at the chosen frequency. It should be clear from Eq. (9.106) that $n_2 > n_1$; accordingly, it is now common practice to designate a (glass)-(high index)-(low index)-(air) system as *gHLA*. Zirconium dioxide ($n = 2.1$), titanium dioxide ($n = 2.40$), and zinc sulfide ($n = 2.32$) are commonly used for *H*-layers, and magnesium fluoride ($n = 1.38$) and cerium fluoride ($n = 1.63$) often serve as *L*-layers.

Other double- and triple-layer schemes can be designed to satisfy specific requirements for spectral

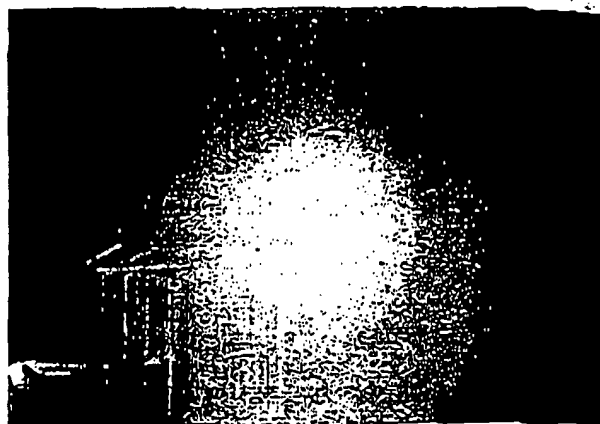


Figure 9.54 Lens elements coated with a single layer of MgF_2 .



Figure 9.55 Lens elements coated with a multilayer film structure. (Photos courtesy Optical Coating Laboratory, Inc., Santa Rosa, California.)

response, incident angle, $\cos \theta$, and so on. Fig. 9.54 is a scene photographed through a 15-element zoom lens, with a 150-W lamp pointing directly into the camera. The lens elements were covered with a single layer of MgF_2 . For Fig. 9.55 a triple-layer antireflection coating was used. The improved contrast and glare reduction are apparent.